

## *Anoplocephaloides dentatoides* sp. n. from the Gray Red-backed Vole, *Clethrionomys rufocanus bedfordiae*, in Hokkaido, Japan

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**ABSTRACT:** Small, wedge-shaped cestodes, *Anoplocephaloides dentatoides* sp. n., were found from the terminal ileum of gray red-backed voles, *Clethrionomys rufocanus bedfordiae*, in Hokkaido, Japan. Prevalence in 48 yearling voles was 33% at 1 locality (43°12'N, 141°27'E) in the early summer of 1989. Morphologically, the new species most closely resembles the European form or population of *Anoplocephaloides dentata* (Galli-Valerio, 1905) Rausch, 1976, which is known principally from *Microtus* spp. in western Eurasia but differs from the latter in the following points: larger cirrus sac, which does not substantially cross the poral excretory canals, female organs situated more centrally in segments, and smaller eggs. In addition, these 2 species apparently differ in host specificity; *A. dentatoides* appears limited to voles of the genus *Clethrionomys*, whereas *A. dentata* is primarily a parasite of *Microtus* spp. (a genus of vole not currently known to occur in Hokkaido, Japan) and has only been incidentally reported from red-backed voles in the Palaearctic.

**KEY WORDS:** *Anoplocephaloides dentatoides* sp. n., *Clethrionomys rufocanus bedfordiae*, taxonomy, Cestoda, Japan.

The genus *Anoplocephaloides* Baer, 1923 emend. Rausch, 1976, is composed of diverse groups of species that have a fundamental similarity in the developmental pattern of the uterus, but that are distinguished based on the form of the strobila, host range, and geographical distribution (Rausch, 1976; Genov and Georgiev, 1988). The group "infrequens" proposed by Genov and Georgiev (1988) consists of species having a small, wedge-shaped strobila and parasitizing rodents of the family Arvicolidae in the Holarctic and Geomyidae in the Nearctic; it includes *A. dentata* (Galli-Valerio, 1905) Rausch, 1976, *A. infrequens* (Douthitt, 1915) Baer, 1923, *A. troeschi* (Rausch, 1946) Rausch, 1976, *A. lemmi* (Rausch, 1952) Rausch, 1976, and *A. kontrimavichusi* Rausch, 1976.

Of that group, *A. dentata* is the only species considered to have a distribution limited to the Palaearctic, whereas other species are endemic to North America or have holarctic ranges. The former species occurs exclusively in *Microtus* spp. (*M. nivalis*, *M. subterraneus*, *M. guentheri*, *M. arvalis*, and *M. oeconomus*). Infrequently, however, this species has been recorded from voles of the genera *Clethrionomys* and *Apodemus* (Zarnowski, 1955; Gubanov and Fedorov, 1970; Murai, 1974; Tenora and Murai, 1980; Tenora et al., 1986).

We found a high prevalence of small, wedge-shaped cestodes of the genus *Anoplocephaloides*

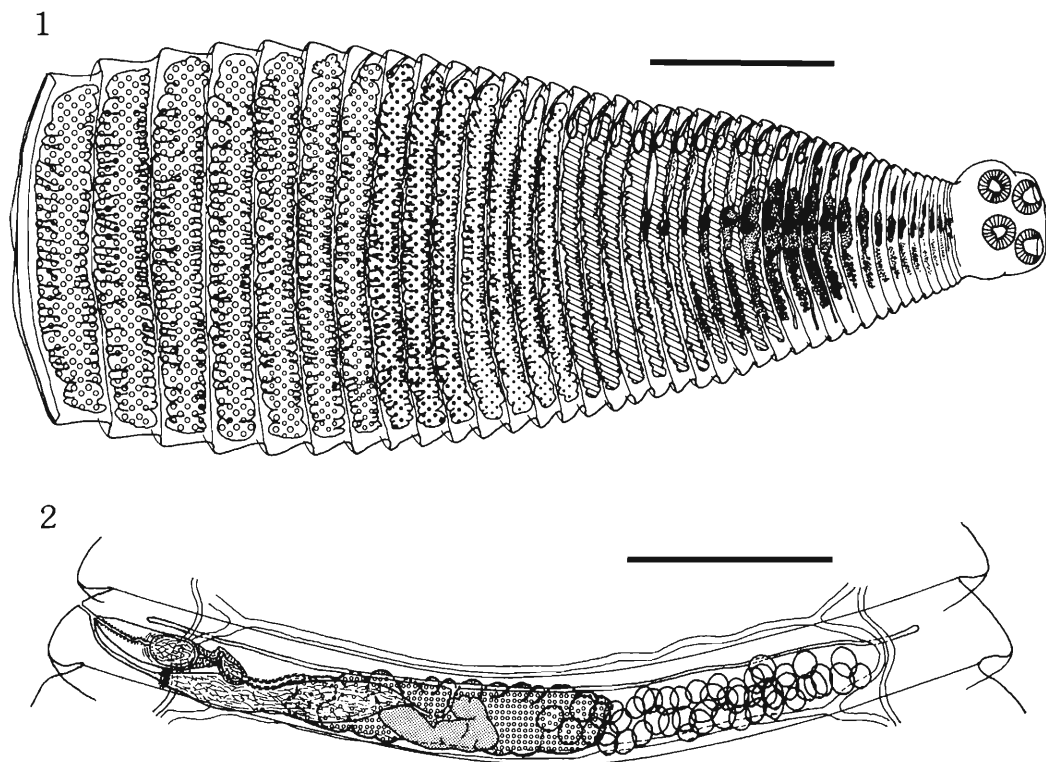
in gray red-backed voles, *Clethrionomys rufocanus bedfordiae*, in Hokkaido, Japan, where no *Microtus* spp. occur. Morphologically, these cestodes most closely resembled *A. dentata*, but some important differences existed. Thus, we describe the specimens as *A. dentatoides* sp. n. and discuss the differences from *A. dentata*.

### Materials and Methods

Gray red-backed voles were collected in a wind shelter-belt on the Ishikari Plain (Tohbetu; 43°12'N, 141°27'E), Hokkaido, Japan, on 28 May and 5 July 1989. For age determination of the host, second and third molars were collected at necropsy, and the shape and root ratio were evaluated according to the method of Abe (1976). After removal from the host, cestodes were relaxed in water, lightly pressed at fixation in hot 10% formalin, stained with Semichon's carmine, and mounted by conventional technique. Drawings were made with the aid of a camera lucida. The asymmetric situation of female organs in segments was represented as an index *A*:*B*, where *A* was the distance between the poral segmental margin and the center of vitelline gland and *B* was the width of that segment. Egg capsules and oncospheres were measured using both mounted specimens and egg suspension from gravid segments preserved in formalin. All measurements given below are in millimeters with the range followed by the mean and standard deviation (*N* = 12) in parentheses.

### Results

The voles examined consisted of 48 yearlings >9 (±2) mo old and 13 juveniles <2 mo old. Small, wedge-shaped cestodes were found in the



Figures 1, 2. *Anoplocephaloides dentatoides* sp. n. from the gray red-backed vole, *Clethrionomys rufocanus bedfordiae*. 1. Whole view of specimen. Scale bar = 2.0 mm. 2. Last mature segment, dorsal view. Scale bar = 0.50 mm.

terminal ileum (1–2 cm above the ileocecal valve) of 16 yearling voles (6 of 17 males and 10 of 31 females). The cestodes had passed into the cecum of voles, which died in captivity. The prevalence was slightly lower in July (28.6% of 14 voles) than in May (35.3% of 34 voles). The intensity ranged from 1 to 3 (9, 3, and 4 voles with 1, 2, and 3 cestodes, respectively); in all, 27 specimens were collected. The following description was based on 12 complete specimens having gravid segments, in which apolysis had occurred.

### Description

#### *Anoplocephaloides dentatoides* sp. n. (Figs. 1, 2)

Strobila wedge-shaped, 7.38–15.28 ( $10.93 \pm 2.70$ ) long. Maximum width 3.46–4.60 ( $4.08 \pm 0.38$ ), attained in the last postmature and/or first gravid segments. All segments wider than long; length:width ratio of mature, postmature, and gravid segments ranging around 1:8.4–16.4, 1:8.0–14.5, and 1:3.8–12.7, respectively. Segmental margins serrate. Scolex 1.080–1.380

( $1.282 \pm 0.086$ ) wide, slightly wider than beginning strobila; suckers round, 0.304–0.384 ( $0.351 \pm 0.022$ ) in diameter. Neck not discernible. Anlagen of genital organs visible in strobila immediately posterior to scolex, where external segmentation not evident. In segments following these immature ones, genital organs developed rapidly. Total number of segments 28–47 ( $39.50 \pm 5.30$ ), including 4–6 ( $4.50 \pm 0.91$ ) immature, 9–13 ( $10.92 \pm 1.73$ ) premature and mature, 12–21 ( $17.5 \pm 2.43$ ) postmature, and 3–9 ( $6.58 \pm 2.07$ ) gravid segments. The last mature segment was the 13th–18th ( $15.42 \pm 1.44$ ) from the first immature segment. Genital ducts passing dorsally across the longitudinal excretory canals. Dorsal canals situated lateral to ventral canals in approximately the same plane. Genital pores unilateral, either sinistral or dextral, near middle of segmental margin. Cirrus sac elongated, slightly extending mediad across the ventral excretory canal; maximum dimensions 0.224–0.416 ( $0.328 \pm 0.048$ ) by 0.082–0.136 ( $0.110 \pm 0.021$ ), attained in the 4th–12th postmature segments. Cir-

rus densely covered with minute spines. Internal seminal vesicle begins to fill in the last mature segments, increasing in size posteriad. External seminal vesicle, smaller than the internal one, extending mediad from the proximal end of cirrus sac. Testes spherical, 0.052–0.076 in diameter, distributed dorsally from the midline of segment laterad to the antiporal ventral excretory canal, slightly overlapping antiporal part of ovary; approximately 50 in number, arranged 3–4 deep. Vagina a thick-walled tube, opening in the genital atrium posteroventrally to orifice of male duct, connected around the dorsal excretory canal to seminal receptacle. Seminal receptacle markedly elongated, extending mediad beyond poral margin of vitelline gland; beginning to fill in the last mature segment, attaining maximum dimensions of 0.400–0.616 ( $0.545 \pm 0.069$ ) by 0.100–0.176 ( $0.143 \pm 0.027$ ) in anterior postmature segments. Lobated ovary transversely elongated, extending mediad beyond midline; situated in poral  $\frac{2}{3}$ – $\frac{3}{5}$  fields of segment. Vitelline gland bilobed, situated dorsally over middle part of ovary near posterior margin of segment. An index of asymmetrical location of the female organs in segment was 0.332–0.440:1 ( $0.392 \pm 0.028$ ) in the last mature segment. Ovary and vitelline gland attaining maximum dimensions in the last mature and/or first postmature segments, thereafter disappearing rapidly; maximum width of ovary 0.536–0.992 ( $0.760 \pm 0.125$ ); maximum width of vitelline gland 0.272–0.536 ( $0.353 \pm 0.073$ ). Uterus first visible as transverse tube, extending beyond the longitudinal excretory canals bilaterally. Egg capsules approximately spherical, with well-developed pyriform apparatus; 0.031–0.034 in diameter, with oncospheres 0.008 in greater diameter, in mounted specimens; egg capsules 0.033–0.039 in diameter, with oncospheres 0.011–0.012 by 0.010–0.011, in formalin-preserved specimens.

**TYPE HOST:** *Clethrionomys rufocanus bedfordiae*.

**TYPE LOCALITY:** Hokkaido, Japan (Tohbetu; 43°12'N, 141°27'E).

**SITE IN HOST:** Terminal ileum.

**SPECIMENS DEPOSITED:** Holotype and paratypes in the National Science Museum, Tokyo (NSMT-PI 4127). Dates for collection of the specimens: 28 May and 5 July 1989.

**ETYMOLOGY:** This new species closely resembles *A. dentata* not only in morphology but also in the host specificity (closely related rodents of

the family Arvicolidae) and Palaearctic distribution, so it is named *A. dentatoides*.

### Remarks and Discussion

Of the "infrequens" group of *Anoplocephaloides* mentioned previously, 3 species, *A. dentata*, *A. troeschi*, and *A. infrequens*, resemble each other in morphology. They had been confused until Rausch (1976) comprehensively redefined the systematics and taxonomic status of these *Anoplocephaloides* species. *Anoplocephaloides dentata* and *A. troeschi* are common cestodes of various *Microtus* spp. in Eurasia (Tenora and Murai, 1980; Genov and Georgiev, 1988) and North America (Rausch, 1952), respectively, while *A. infrequens* is a parasite of the pocket gophers, *Geomys bursarius* and *Thomomys talpoides*, of the family Geomyidae in North America (Rausch, 1976). Specimens of *Anoplocephaloides dentatoides* sp. n. resemble these 3 species in morphology (Table 1). *Anoplocephaloides baeri* Rausch, 1976, having a small strobila of parallel margins occurs also in Hokkaido, Japan, but is a parasite of murid rodents, *Apodemus argenteus* (Rausch, 1976). This species is distinct in morphology from *A. dentatoides* (see Table 1). Asakawa et al. (1983) suggested incidental infections of gray red-backed voles (3 of 175 voles) with *A. baeri* in Hokkaido. The brief description of their materials agrees with *A. dentatoides* rather than *A. baeri* in the following points: the form of strobila (wedge-shaped, not of parallel margins), total segment number (35), sizes of suckers (0.363–0.386 mm in diameter), and eggs (0.033–0.038 mm). Considering that they examined damaged material, we suspect that their tapeworms might be *A. dentatoides*.

*Anoplocephaloides dentatoides* can be distinguished from *A. infrequens* by fewer segments, larger scoleces, and more rapid maturation. The testes of *A. dentatoides* are distributed antiporally between the ventral excretory canal and the midline of the segment, whereas in *A. infrequens* the testes have a somewhat broader distribution and extend porally beyond the midline. Similarly, *A. dentatoides* can be distinguished from *A. troeschi* by wider strobilae, larger scoleces, longer cirrus sacs, and slower maturation. As in *A. infrequens*, the testes of *A. troeschi* extend porally beyond the midline of the segments. The ovary and vitelline gland of *A. troeschi* are situated almost in the center of the segment. Based on these morphological differences as well as the host range

Table 1. Comparison of morphological features (in millimeters) of *Anoplocephaloides dentatoides* sp. n. with some species of *Anoplocephaloides* having small strobiliae.

|                              | <i>A. infrequens</i>  |   |   |   |
|------------------------------|---|---|---|---|
|                              | <i>A. dentata</i>   |   | <i>A. troeschi</i>                                  | <i>A. baeri</i>                                     |
| Genus of main host:          | <i>Clethrionomys</i>  | <i>Microtus</i>                                     | <i>Microtus</i>                                     | <i>Apodemus</i>                                     |
| Geographical distribution    | Japan (Hokkaido)  | Western Eurasia (Europe)                            | Eastern Eurasia (Northeastern Siberia)              | Japan (Hokkaido)                                    |
| Reference                    | The present work  | Genov and Georgiev, 1988                            | Rausch, 1976  | Rausch, 1976  |
| Whole length                 | 7.38–15.38<br>(av. 10.9)  | 7.0–12.2<br>(av. 8.5)                               | 5.5–8.0<br>(av. 6.2)                                | 10.5 and 18<br>(av. 13.4)                           |
| Maximum width                | 3.46–4.60<br>(av. 4.08)   | 2.30–4.33<br>(av. 3.25)                             | 2.0–2.5<br>(av. 2.4)                                | 3 and 3.5<br>(av. 2.2)                              |
| Number of segments           | 28–47<br>(av. 39.5)   | 33–45<br>(av. 37.8)                                 | 27–35<br>(av. 32)                                   | 60 and 73<br>(av. 49)                               |
| Last mature segment          | 13–18<br>(av. 15.4)   | 13–15   | 9–12<br>(av. 11)                                    | 17 and 20<br>(av. 18)                               |
| Scotex width                 | 1.080–1.380<br>(av. 1.282)  | 0.912–1.280<br>(av. 1.128)                          | 0.650–1.2<br>(av. 1.0)                              | 0.580 and 0.672<br>(av. 0.711)                      |
| Number of testes             | ca. 50  | 41–67<br>(av. 49.7)                                 | ca. 50  | 50–60   |
| Maximum length of cirrus sac | 0.224–0.416<br>(av. 0.328)  | 0.175–0.325<br>(av. 0.249)                          | 0.350   | 0.360   |
| Distribution of testes       | Midline of segment, slightly overlapping antiporal part of ovary, to antiporal excretory canals |   |   |   |
| Eggs                         | 0.033–0.039   | 0.040–0.053<br>× 0.040–0.050<br>(av. 0.047 × 0.044) | 0.039–0.051<br>× 0.032–0.049<br>(av. 0.042 × 0.038) | 0.039–0.044<br>× 0.034–0.041<br>(av. 0.041 × 0.036) |

and geographical distribution, *A. dentatoides* shares more similarities with *A. dentata* than with *A. infrequens* or *A. troeschi*.

Two morphological forms of *A. dentata* have been known since Spasskii (1951) distinguished its European (Caucasian) and Siberian forms on the basis of different number of testes, 30 or fewer in the former and approximately 50 in the latter. Additionally, *A. dentata* from Siberia has smaller strobilae and longer cirrus sacs. Rausch (1976) considered that these 2 forms probably represented distinct species, and, thence, *A. dentata* was generally regarded as a composite species. Recently, it became apparent that the number of testes in *A. dentata* from Europe and Siberia was comparable (Tenora and Murai, 1980; Genov, 1984; Tenora et al., 1986; Genov and Georgiev, 1988), although these forms can apparently be differentiated by other morphological characters.

As evident in Table 1, *A. dentatoides* can be easily distinguished from *A. dentata* from Siberia. Although *A. dentatoides* and *A. dentata* from Europe share many similarities, some important differences exist between them in the maximum length of the cirrus sac, the relationship of the cirrus sac with the excretory canals, the location of female organs, and egg size.

In their detailed comparative study, Genov and Georgiev (1988) stated that the cirrus sac of *A. dentata* from Europe substantially crossed the excretory canals. The cirrus sac of *A. dentatoides*, albeit apparently larger than that of *A. dentata* from Europe, attains but does not substantially overlap the excretory canals. The female organs of *A. dentatoides* are situated more centrally in the segment than *A. dentata* from Europe. Genov and Georgiev (1988) described that the ovary of *A. dentata* from Europe reached up to the cirrus sac porally and to the middle of the segment antiporally, when fully developed. On the other hand, the ovary of *A. dentatoides* was situated more centrally, extending antiporally beyond the midline of the segment. The index of asymmetric situation of female organs of *A. dentata* from Europe is as follows: 0.310–0.351:1 (av. 0.330), 0.303–0.372:1 (av. 0.337), and 0.281–0.378:1 (av. 0.337) for specimens from *M. nivalis*, *M. subterraneus*, and *M. guentheri*, respectively (Genov and Georgiev, pers. comm.). That index was 0.332–0.440:1 ( $0.392 \pm 0.028$ ,  $N = 12$ ) in the present specimens. These figures support the finding that the female organs of *A. dentatoides* are situated more centrally than those of *A. den-*

*tata*, although the ranges are overlapped considerably and Erhardova and Rysavy (1955) described centrally located ovaries of *A. dentata* from *M. arvalis* and *C. glareolus*. More data are needed as to this point. Genov and Georgiev (1988) reported variations in the size of eggs of *A. dentata* obtained from different *Microtus* spp., and Rausch (1952) reported that both size range and average size can differ considerably from 1 locality to another in a related species, *A. troeschi*. Without considering these possibilities, the present specimens have apparently smaller eggs than *A. dentata* from Europe.

The 2 species, which most closely resemble each other, *A. dentatoides*, and the European form of *A. dentata*, are separated geographically, and the area of distribution of the Siberian form of *A. dentata* is interposed. This may support the recognition of *A. dentatoides* as a previously undescribed species. Another support is the fact that *A. dentatoides* apparently is host-specific. *Anoplocephaloides dentatoides* were obtained from gray red-backed voles from Hokkaido, Japan, where *Microtus* spp. are not currently known to occur. As already mentioned, *A. dentata* is a common cestode in various *Microtus* spp. in the Eurasian continent, but infrequent in voles of the genus *Clethrionomys* there. Its prevalence is as follows: 2.5% of 80 *C. glareolus* (Zarnowski, 1955), 2.0% of 324 *C. glareolus* (Tenora, 1967), 0.3% of 295 *C. glareolus* (Murai, 1974), 1.1% of 532 *C. rufocanus* (Haukisalmi et al., 1987), and 0.3% in 1,750 *C. rutilus* (Gubanov and Fedorov, 1970). Rausch, who carried out an extensive field survey in northeastern Siberia, could not find *Anoplocephaloides* species in *C. rufocanus* and *C. rutilus*, but commonly did in *Microtus* spp. (pers. comm.). These findings imply that *A. dentata* occur only accidentally in voles of the genus *Clethrionomys*. On the other hand, the prevalence shown in the present study is high enough to consider that voles of the genus *Clethrionomys* are the true hosts of *A. dentatoides*.

Geographical distributions of *A. baeri* and *A. dentatoides*, both of which appear to be host-specific, have been recorded only from Hokkaido, Japan, and we are greatly interested in whether or not these cestodes occur also in the neighboring area of the Eurasian continent.

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